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# PSYCHE

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PSYCHE

VOL. XLVII MARCH, 1940 No. 1

# OBSERVATIONS IN CUBA ON INSECT MIMICRY AND WARNING COLORATION.

By C. T. PARSONS

Biological Laboratories, Harvard University

The following cage experiments on mimicry and warning coloration were conducted at the instance of an article by P. J. Darlington, Jr.[1] This paper is intended to supplement rather than to repeat Dr. Darlington's extensive remarks on the environment in which the mimicry occurs. These few observations, incidental to other work, are fragmentary. Yet opportunity to gather such information is so rare that the following notes are thought worthy of record.

The writer is greatly indebted to Dr. Thomas Barbour who made possible the stay in Cuba under a Harvard Fellowship of the Atkins Institution at Soledad, near Cienfuegos. Professor C. T. Brues very kindly took charge of the special photography involved. Also to Dr. Darlington and Doris H. Blake for advice and assistance in identifying the insects the writer is under obligation.

Dr. Darlington described an example of mimicry, occurring at Soledad, in which a lizard, *Anolis sagrei* (D. & B.) is the chief predator. In his experiments Darlington observed that the *Anolis* refused beetles of several different families. Apparently these were mimics of two very similar species of inedible Lycid beetles, *Thonalmus suavis* (J.—D.) and *T. aulicus* (J.—D.).

An examination of the plate of photographs should elucidate the descriptions that follow.

---

[1] P. J. Darlington, Jr., 1938, Experiments on mimicry in Cuba with suggestions for future study. Trans. R. ent. Soc. London, 87: 681-695.

## EXAMPLES OF MIMICRY: THONALMUS-LIKE BEETLES

*Callopisma adjuncta* E. Oliv. (Lampyridæ): Darlington states that it is a forest dweller, but one specimen was found in open country on the same tree with *Thonalmus*. Since no more were seen, it was not used experimentally. This *Callopisma* is about the same size as a small *Thonalmus;* the pronotum and anterior fifth of elytra are orange and the rest of the elytra are black. Two specimens of a yellow and black Lampyrid (*Photinus nefarius* E. Oliv.), of similar size, were readily eaten by an *Anolis sagrei*.

*Drapetes bicolor* Cast. (Throscidæ): This beetle was not mentioned by Darlington. It was found in company with *Thonalmus* but is only 4.2 mm. long, whereas the length of the smallest *Thonalmus* is 6 mm. The head and pronotum are reddish orange and the elytra are metallic blue-green. Unfortunately *Drapetes* quickly died in captivity. Of six examples placed with three separate *Anolis sagrei*, all died within 24 hours, but only one of them was eaten.

*Chalepus sanguinicollis* Linn. (Hispidæ): Although not mentioned by Darlington, *sanguinicollis* occurred in company with *Thonalmus*. It is larger than the smallest *Thonalmus* and with orange or red on the pronotum and anterior third of elytra, extending posteriorly along the lateral margins. The head and remainder of the elytra are black. One specimen, placed with *Anolis sagrei*, was eaten by the following day.

*Trichrous pilipennis* Chev. (Cerambycidæ): In Darlington's cage experiments an example of this species survived five days, at which time his experiment was closed. During the writer's experiments, in the course of a week, six *Trichrous* were placed with an *Anolis sagrei*, two of which were eaten the first day, another two days later; two died after being in the cage two days; and one was alive after three days in the cage. Of three *Trichrous* placed with another *sagrei*, one was eaten and one died on the second day, and the remaining example died four days later. Still another *Anolis sagrei* failed to eat a *Trichrous* during five days, when the experiment was closed. During these experiments a variety of other insects were eaten. In order to test the edibility of *Trichrous*, a *Thonalmus*, placed in the mouth of a *sagrei,* was rejected; then a *Trichrous* was swallowed at once. The observations indicate that although the *Trichrous* is edible, the *Anolis* has a strong tendency to avoid this Cerambycid.

A single specimen each of *Anoplischius venustus* (J.—D.) (Elateridæ) and *Calocosmus venustus* Chev. (Cerambycidæ) were taken at Soledad in June, but no more were found. Darlington collected both these species in May and illustrated them in his paper.

## EXAMPLES OF POSSIBLE WARNING COLORATION

In company with *Thonalmus* and therefore in the same environment as *Anolis sagrei* occurred several brightly colored inedible insects. The cage experiments strongly suggest that these insects are examples of warning coloration.

### *Hemiptera Refused*

The following Hemiptera were not eaten, although *Anolis* readily ate plain-colored Hemiptera. Both the *Dysdercus* and the *Oncopeltis* exude a pink body fluid when handled; also *Dysdercus* has a characteristic odor.

*Euryopthalmus sellatus* (Guér.) (Pyrrhocoridæ): This species is 9-12 mm. in length. On the upper side the pale markings are cream colored, with a narrow orange margin. The anterior, middle, and base of posterior femora are orange. The rest of the upper surface is black. Of two pairs placed with two separate *Anolis sagrei,* two died the following day and two were alive five days later.

*Dysdercus andreæ* (Linn.) (Pyrrhocoridæ): The length of this species is 8-10 mm. The pale markings, as indicated in the photograph, are red and the rest of the upper surface black. Of two pairs placed with two separate *Anolis sagrei,* both were dead the next day. Darlington also found that this and the preceding species were not eaten.

*Oncopeltis fasciatus* (Dall.) (Lygæidæ): This species is 12 mm. long with pale markings orange and the rest black. One example was alive after four days with an *Anolis sagrei.*

It seems pertinent here to quote a passage from Usinger (Univ. Calif. Publ. Ent., 7: 38, 1939). "It is interesting that several predaceous Hemiptera from Cuba are strikingly marked with the same brilliant red and sharply contrasting black colors as are seen in *Callotriatoma*. Thus *Apiomerus burmeisterii* Guerin and *Enicocephalus cubanus* Bruner are the only representatives of their respective genera (excepting other closely allied Antillean species) with such coloration. Too much of the literature on mimicry and warning coloration is made up of idle speculation based upon museum specimens, but suggestions from this source may be of value if they point out where field work may best be concentrated. If the species just named occur in the same area, it would appear that they would be mutually benefited by combining their efforts along a single line of sematic coloration."

### *Edible Hemiptera*

In company with the inedible Hemiptera were placed several plain-colored species that were taken readily by *Anolis*. In addition to the following, two other unidentified bugs were quickly eaten.

*Mormidea pictiventris* Stal (Pentatomidæ): The length is 8 mm., with cream colored marks on a brownish grey upper surface. Of five specimens fed to three separate *Anolis sagrei*, all were eaten within twenty-four hours.

*Oedancala cubana* Stal (Lygæidæ): The length of *cubana* is 8 mm. and the upper surface is yellow brown. One example was eaten at once.

### *Coleoptera Refused*

*Pachnæus azurescens* Sch. (Curculionidæ): This 10 mm. bluish cream weevil was not eaten after six days with an *Anolis sagrei*, whereas several greyish black weevils (*Lachnopus* near *hispidus* Boh.) of the same size were taken readily.

*Oedionychis fasciata* Fabr. (Chrysomelidæ): According to Mrs. Blake the specimen used is actually a new species heretofore confused with *fasciata*. The pronotum and transverse elytral band are orange, and the rest of the elytra are bluish-purple. This 5 mm. beetle was not eaten after two days with an *Anolis sagrei*.

A striking example of what is apparently warning coloration is shown in the case of the Chrysomelid *Cryptocephalus viridipennis* Suffr., a shining metallic blue-green beetle with dark reddish brown pronotum and transverse band on elytra. Of three specimens placed with three separate *Anolis sagrei,* one was not eaten after six days, another after five days, but one was taken after four days. Whereas *Anolis* ate more or less quickly three closely related species: *Cryptocephalus 5-punctatus* Suffr. yellow with black spots, *C. commutatus* Suffr. reddish brown to metallic blue with yellow marks, and *Pachybrachys parallelopedus* Suffr. with brown and yellow markings.

Three species of brightly colored Coccinellidæ, *Chilocorus cacti* (L.) *Cycloneda sanguinea* (L.) and a third unnamed, were refused by *Anolis sagrei.*

### *Edible Coleoptera*

With the bright colored inedible beetles were put sombre beetles that *Anolis* usually ate without hesitation. Two such beetles were the Elaterids *Conoderus bifoveatus* (Beauv.) and *Aeolus* sp. Darlington mentions others that he used. Also an occasional house fly and a cockroach nymph was greedily snapped up by the lizards.

## DISCUSSION

Darlington found, in his feeding experiments with *Thonalmus,* that his results were absolute and surmised that they might prove to be statistical instead. That they may be statistical is shown by the present writer, especially in the case of *Trichrous.*

Another implication brought out by the experiments is that the feeding habits vary with the individual, probably as a result of the experience of each lizard.

An interesting aspect of the experiments is the variation in the markings of insects which are refused for no apparent reason other than mimicry or warning coloration. In some cases, as *Chalepus* and *Drapetes,* the mimicry is not close. Or a beetle, such as *Oedionychis,* may have the models' colors in a very different pattern. One beetle, *Cryptocephalus viridipennis,* has only one of the models' colors. Also the colors of *Thonalmus* and the inedible Hemiptera are similar. So

*Anolis* seems to refuse all bright red and blue and red and black insects. If this should turn out to be true, then there would be a mutual Müllerian reinforcement of mimicry by warning coloration.

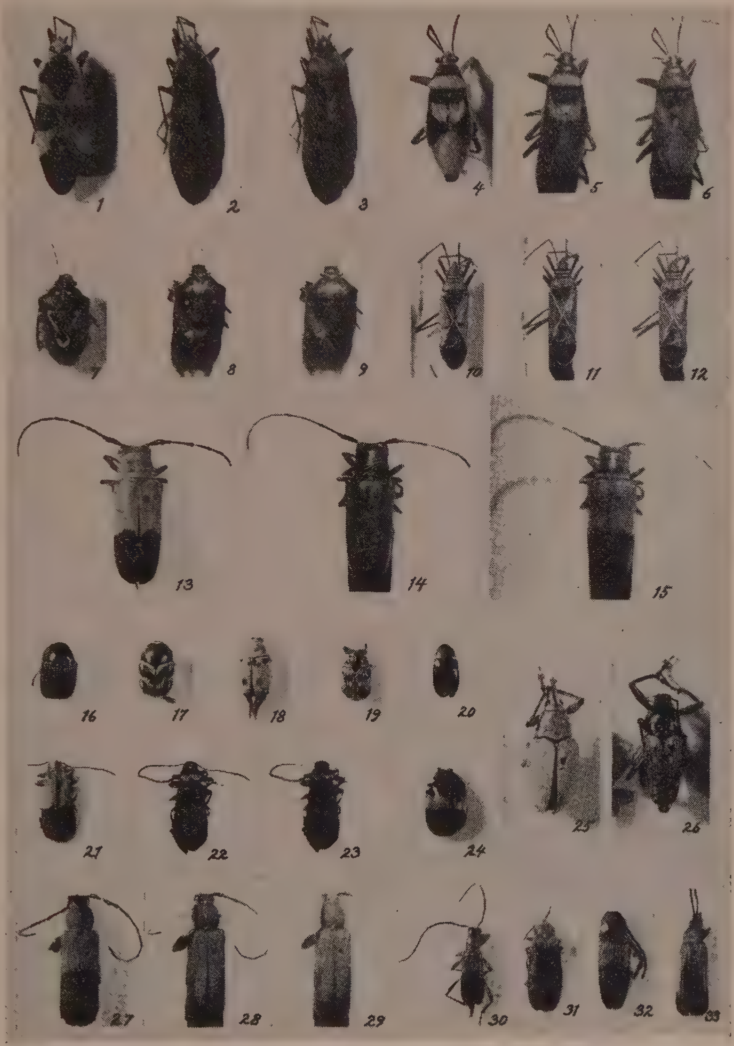
Professor Brues' photographs show that the pattern appears in ultra violet light in only one instance but is more or less present in the longer wave-lengths emitted by fluorescense.[2] Apparently the visible spectrum must be approximately the same for *Anolis* and man. Certainly, the testing of the visible spectrum of *Anolis* would be a pertinent study.

## EXPLANATION OF PLATE I.

Figs. 1-33. Insects used in mimicry and warning coloration experiments. Unless stated otherwise, the photographs were taken by white light. 1, *Oncopeltis fasciatus;* 2, by fluorescent lights; 3, by ultra violet. 4, *Euryophthalmus sellatus;* 5, by fluorescent light; 6, by ultra violet. 7, *Mormidea pictiventris;* 8, by fluorescent light; 9, by ultra violet. 10, *Dysdercus andreae;* 11, by fluorescent light; 12, by ultra violet. 13, *Calocosmus venustus;* 14, by fluorescent light; 15, by ultra violet. 16, *Cryptocephalus viridipennis.* 17, *Cryptocephalus commutatus.* 18, *Cryptocephalus 5-punctatus.* 19, *Pachybrachys parallelopedus.* 20, *Drapetes bicolor.* 21, *Thonalmus aulicus* (small specimen); 22, by fluorescent light; 23, by ultra violet. 24, *Oedionychis* n.sp. (near *fasciata*). 25, *Pachnaeus azurescens.* 26, *Lachnopus* near *hispidus.* 27, *Trichrous divisus* Chev.; 28, by fluorescent light; 29, by ultra violet. 30, *Trichrous pilipennis.* 31, *Callopisma adjuncta.* 32, *Anoplischius venustus.* 33, *Chalepus sanguinicollis.*

[2] The photographs were made with a mercury vapor source with quartz condensing lens. To register reflected ultra-violet light a dark purple filter excluding wave lengths longer than 4000 angs. was interposed between the source of light and object. To register fluorescence, an additional filter excluding lengths below 4000 angs. was added, between the object and the camera lens. Photographing by white light was done with tungsten filament flood-lights, without filter, on a panchromatic emulsion.

Psyche, 1940 VOL. 47, PLATE I.



Parsons — Insect Mimicry

# A NOTE ON THE EARLY STAGES OF *LEPISELAGA CRASSIPES* FAB. (DIPT., TABANIDÆ)

By G. B. Fairchild,

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Gorgas Memorial Laboratory,
Panamá, R. de P.

Information about the early stages of Neotropical Tabanidæ may almost be said to be non-existent. Bodkin and Cleare (1916) have given a brief description of the larvæ and a figure of the pupal aster of *Tabanus desertus* Wlk. Ad. Lutz (1920, 1922 and 1928) has mentioned raising a few species from larvæ, and has described a method of rearing using agar as a medium (1920), but so far as I am aware these are the only descriptions or figures of larvæ or pupæ of any of the many Neotropical forms that have ever been published.

Inasmuch as the classification of the Tabanidæ, so far based entirely on adult characters, is in a very unsatisfactory condition, I feel that any information about the structure and habits of the early stages is very important, and may throw some much needed light on the relationships of the many forms.

The present species has apparently been reared more often than any other, and has been mentioned several times in the literature. Ad. Lutz (1928) raised a single adult from a larva collected in plants of *Pistia stratiotes*, the water lettuce, in Venezuela, and gives an unrecognizable figure of the pupal shell. Dunn (1934) also raised the adults from larvæ taken in the same habitat in Panama, but says nothing about the appearance of either larva or pupa.

During the early months of 1929, while searching for mosquito larvæ in the floating vegetation along the Chagres

River between Gamboa and Madden Dam in the Panama Canal Zone, I occasionally dipped up small pupal shells of what I suspected might be *Lepiselaga.* Comparison of these with a specimen in our collection from which Dunn had bred *Lepiselaga* confirmed my suspicion.

Although, for reasons which are not known, *Pistia* has become very scarce throughout the Canal Zone this year, I have taken the adult *Lepiselaga* in fair numbers throughout the year. I suspect, therefore, that it is not entirely dependent on this plant, but may be associated with other types of aquatic vegetation as well. In April 1939, while collecting in a small slough near the laboratory's station at Juan Mina on the Chagres River, I secured two small greenish larvæ from the matted floating vegetation near the shore line. This vegetation consisted of floating debris, mats of filamentous algæ, the water-fern *Salvinia,* and a few small plants of *Pistia* not over 1.5 inches in diameter. The larvæ were associated with a rather rich fauna of aquatic insects, including larvæ of *Odonata, Ephemerida* and *Stratiomyiidæ,* and numerous species of aquatic *Coleoptera* and *Hemiptera.* At the same time I also took two pupal shells. Later, in mid-May of the same year, I collected two more larvæ of *Lepiselaga* in a grassy swamp near Gamboa. They were in the floating scum on the water, and no *Pistia* was present in the swamp.

The first two larvæ were kept in the laboratory in shell vials measuring 3 x 1 inches, into which about 1 inch of 2% agar had been poured. This medium remains more or less transparent for one or two weeks, when the larvæ may be removed to a new tube if it is desired to keep them under close observation. Inoculation of the medium with some unicellular green alga seems to keep the medium from becoming putrid for a longer time, but the dark green color interferes with observation. To provide a suitable place for pupation, paper towelling is cut into strips 1.5 inches wide and 3 or 4 inches long, rolled into a cylinder the size of a lead pencil, moistened and inserted upright into the agar. The tubes are stoppered tightly with cotton, which must not touch the roll of paper, or it will suck all excess moisture from the paper and agar. The larvæ may be fed upon aquatic earthworms, *Chironomid* larvæ or other small softbodied forms, but I have found the most satisfactory food to be ordinary earthworms. A culture of these may be kept in the laboratory for long periods, and one fair-sized worm cut in pieces will feed ten or a dozen larvæ.

After about 3 weeks in the laboratory, during which they both fed several times, one of these larvæ pupated, yielding a pupa which resembled the empty pupal shells I had previously found. The other was hastily preserved for study. I was obliged to leave the laboratory for five days after this, and when I returned, found that a male *Lepiselaga* had emerged in my absence, so that the pupal period is not more than a week and probably 4 or 5 days.

The full-grown larva is about 15 mm. long by 3-3.5 mm. wide at the widest part in the region of the 5th or 6th segment, circular in cross-section, or sometimes slightly flattened ventrally. In color it is a light yellowish green with a complicated dorsal pattern of dark grey spots and blotches on the second to tenth segments. Laterally there are two short parallel longitudinal dark lines of spots; below there is a dark spot on each of the second to 10th segments. The ventral surface is unmarked, as are the first and last segments. Both the head and siphon are unusually slender, and the anterior part of the body has great powers of extension, so that when extended in crawling the head and first two segments may make up ¾ of the total length. The locomotory protuberances include a narrow transverse dorsal pair, a rounded lateral protuberance on each side, and an oval ventral pair. Thus each segment from the 6th to the 10th inclusive bears 6 protuberances. The 5th segment lacks the ventral pair, and the dorsal pair are narrowed. These protuberances are extensile to some extent and bear dense short hairs. There are also a few long hairs in the head and anal regions, and at least a lateral pair on each segment, which are difficult to see. The anal region is less swollen than in other Tabanid larvæ I have seen, and does not appear to be used so much in locomotion. The apical part of the siphon is rather heavily chitinized and longitudinally striated, and bears near its apex four groups of three hairs each. The opening at the apex is a vertical slit fringed with minute hairs. In this slit, and lying between the ends of the two big tracheal trunks, is a heavily chitinized spear-like structure which seems to be capable of considerable extrusion and retraction. Hart (1895) mentions this structure as being present in all the Tabanid larvæ he examined, but noted that it was retractile, so that in many specimens it was not visible. He gives a figure of it in lateral view for *Tabanus nigrescers.* Stone (1930) also mentions this structure and uses it in his key, it being found in some species of *Chrysops* and *Tabanus* but not in others. Such a structure would seem quite well adapted to piercing the air spaces in the roots and leaves of such aquatic plants as *Pistia* and *Piaropus*, while allowing the larva to secure air from the water surface when such plants are not available. In any case, the larvæ live quite well under artificial conditions, apparently not needing aquatic vegetation from which to secure air.

The pupa is 10-14 mm. long, the abdomen relatively short, for the head and thoracic region are only slightly less than half the total length of the pupa. The head-capsule is smooth and rounded, lacking the bosses and rugosities often found in other species of the family. The thoracic spiracles are produced into relatively long conical trumpets, which are directed sidewise with their openings on the ventral side of the apex. These elongated thoracic trumpets have been found in only one other Tabanid, so far as I am aware. King (1926) records similar structures for *Tabanus fasciatus niloticus* Aust., a species which he found breeding in *Pistia* on the Nile. The 1st. to 4th. free abdominal segments bear long spines where the spiracles should occur. These at first sight appear to be breathing-tubes, but I cannot find that they are open at the apex. Each abdominal segment in addition bears a row of fine spines of variable length near its posterior margin, which are longer on the dorsal side. The female aster is shown in Fig. 5. The male aster is narrower, the lateral spines are relatively longer, and the ventral region of the last segment is considerably inflated. In color the pupa is light leaf green, becoming nearly black before emergence, when the colors of the adult can be clearly seen through the integument.

## EXPLANATION OF PLATE II.

Fig. 1. Dorsal view of full grown larva of *Lepiselaga crassipes*, showing distribution of locomotory protuberances. Color markings omitted.

Fig. 2. Dorsal view of 7th segment, showing color pattern.

Fig. 3. Dorsal view of Siphon. a. tracheal trunks. b. apical slit. c. siphonal spear.

Fig. 4. Lateral view of ♂ pupa.

Fig. 5. Terminal view of last segment and aster of ♀ pupa.

## REFERENCES.

1895 Hart, C. A. On the Entomology of the Illinois River and Adjacent Waters. First Paper. Bull. Illinois State Lab. Nat. Hist. IV, Article Vi. p. 222, pl. XI, Fig. 48. Urbana, Illinois. 1895.

1916 Bodkin, G. E. and Cleare, L. D., Jr. Notes on some animal parasites in British Guiana. Bull. Ent. Res., VII, p. 184, Fig. 1, 1916.

1920 Ad. Lutz, Obervação de vermes e larvas terrestres ou limicolas em ambiente transparente. Folha Medica, Anno. 1, No. 3, March 1920 (Separate).

1922 Ad. Lutz, Zoologia Medica. Folha Medica, p. 89. (Separate).

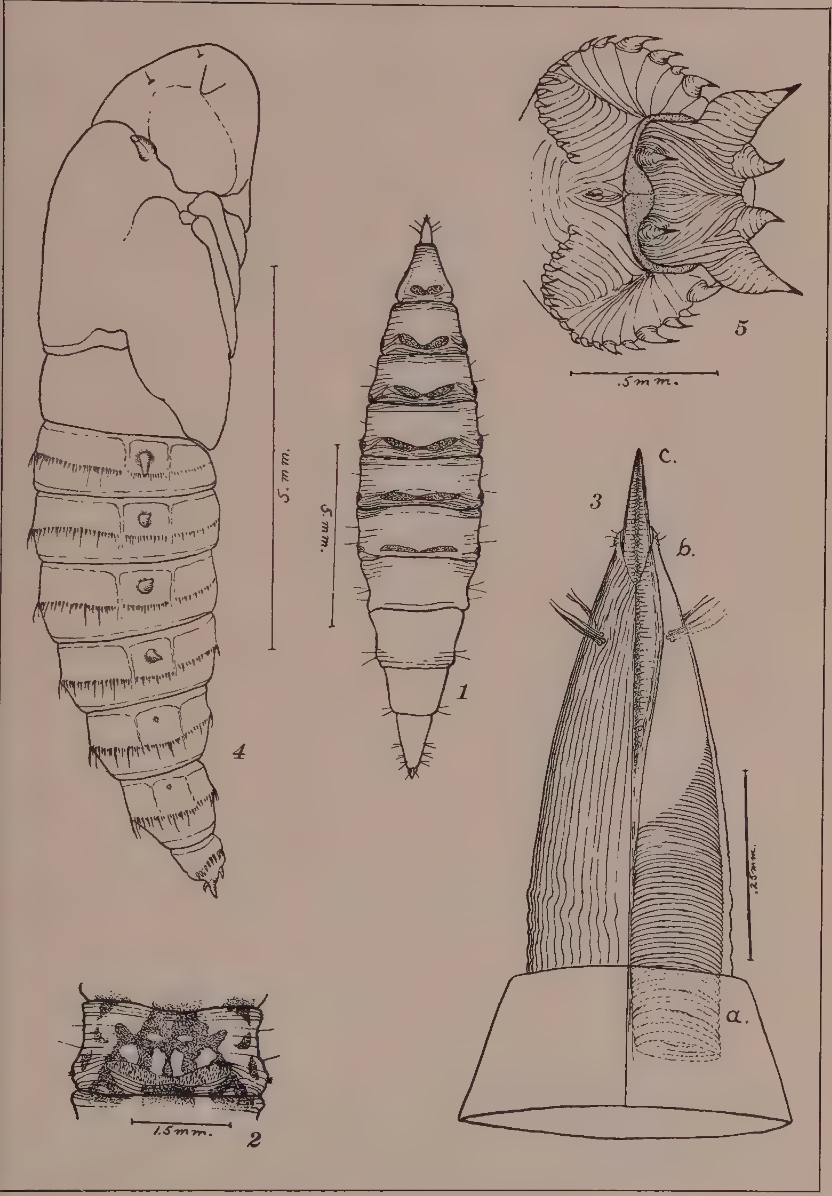
1926 King, H. H. A note on the bionomics of *Tabanus fasciatus niloticus* Aust. Bull. Ent. Res., *16*, p. 359, March 1926.

1928 Ad. Lutz, Estudios de Zoologia y Parasitologia Venezolanos, Rio de Janeiro, pp. 59-60, pl. 3, fig. 7, Dec., 1938.

1930 Stone, Alan. The Bionomics of some Tabanidae (Diptera) Ann. Ent. Soc. Amer. XXIII, 2, pp. 261-304, Figs. 1-12, June 1930.

1934 Dunn, L. H. Notes on the water lettuce, *Pistia stratiotes*, as a nursery of insect life. Ecology, XV, No. 3, pp. 329-333, July 1934.

Psyche, 1940 Vol. 47, Plate II.



Fairchild — *Lepiselaga crassipes*

# LIFE HISTORIES OF CUBAN LEPIDOPTERA

By V. G. Dethier

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Cleveland, Ohio

## Introduction

The life histories described in this paper are, for the most part, those of insects whose immature stages have hitherto been unknown. Also included are accounts which supplement the descriptions of species treated by earlier authors. Even the most meager notes are included here because it is felt that every fact however brief aids in the further study of a life history. For a list of previous studies of some of these species the reader is referred to Davenport and Dethier (1937). Color descriptions are based upon a comparison with Ridgway's (1920) color charts.

This work was made possible by a Harvard University Fellowship which enabled the author to pursue research at the Atkins Institution of the Arnold Arboretum in Soledad, Cuba.

### **Calisto herophile** Hbn.

*Egg*

Ivory yellow to white when laid. Nearly spherical. Covered with a fine raised reticulation forming minute polygonal areas. A day or more after being laid the egg develops tawny-olive markings (Figs. 5, 6, and 8).

*First Instar*

Head height .6 mm.; head width .7 mm. General color of head bronze. Entire surface covered with a fine irregular dark brown raised reticulation. The background of the frontal areas is lighter than the rest of the head. Ocelli white. Edge of clypeus and mandibles dark brown. There are a few colorless tapering hairs and characteristic protuberances (Fig. 3). Body length 2 to 4 mm. Newly hatched larva ivory yellow striped with ochraceous-buff (Fig. 11). Anterior portion of body light ochraceous-salmon. After eating the anterior portion of the body becomes greenish. The mid-dorsal, para-dorsal, and suprastigmatal lines become brownish. The stigmatal and infrastigmatal lines become dark greenish. The background of the body is now whitish green. On segments one and two at the para-dorsal line there is a black splotch slightly more anterior in position than the dark brown spiracle. A few long colorless hairs with bulbous tips are scattered over the body. Those on the posterior segments are the longest. Those on the prothorax are longer than the ones on the remaining thoracic segments.

*Second Instar*

Head height .6 mm.; head width .7 mm. General color very light brown to gray. Surface granular. Three rather indistinct streaks composed of rather minute gray to fuscous dots extend over the head. They merge to a varying degree (Fig. 1). On the posterior part of the head in particular these three streaks are more or less continuations of the dorsal longitudinal lines of the body. The background is the color of parchment. There are numerous short colorless hairs arising from conspicuous black tubercles. Prominent on the sides of the head are two irregular black protuberances. Body length 4 to 5.5 mm. The wide dorsal, the thin paradorsal, and the wide suprastigmatal lines are sayal brown. On either side of the para-dorsals are irregularly marked light brown bands. The black splotch in the para-dorsal is largest on segment three. Between the suprastigmatal and stigmatal lines is a thin band of plumbago blue. The stigmatal line is outlined with darker brown and the infrastigmatal line is plumbago blue. Spiracles dark brown. Ventum dead grass yellow. Many short colorless tapering hairs cover the body.

*Third Instar*

Head height .9 mm.; head width 1.0 mm. Head differs but little from previous instar. It is lighter due to the smaller extent of dark streaks. Body 6 to 8.5 mm. long. Bands on body more distinct. On each segment in addition to the para-dorsal and suprastigmatal black splotches there is now a black spot on the border of the mid-dorsal line. Further changes in the body markings are shown in Fig. 9. The substigmatal line is white and very broad.

### *Fourth Instar*

Head height 1.25 mm.; head width 1.25 mm. The only black now remaining on the head is an indistinct transverse band between the two prominent knobs, a short band extending posteriorly from each knob to the foramen magnum, and a slight black area near the ocelli. Body length 9 mm. Not much change. Markings intensified.

Eggs were laid May 6 and 7 and hatched May 13 and 17 six to eleven days having elapsed. The first instar required seven days all moults having been completed by May 24. The second instar occupied from twelve to fourteen days with moults on May 29 and June 2. The third instar was completed in eight days and the fourth in ten. Many different species of grass served as food plants, but lawn grass was preferred.

## **Metamorpha stelenes insularis** (Holland)

### *Egg*

Dark pea green. Height 1.2 mm. Greatest diameter .9 mm. There are fourteen raised white longitudinal ribs. At the apex of the egg the ribs present a few serrations when viewed in profile. Here also they join to form a stem-like projection on the summit of which is located the micropyle. The base of the egg, the surface applied to the food plant, is perfectly flat. It is divided into faint minute polygonal areas.

### *First Instar*

Head height .5 mm.; head width .75 mm. Smooth shiny black with a few long black hairs. These are in part microscopically serrate. Body 3 mm. long. Clear transparent burnt yellow. Green from gut shows through. Few long black serrate hairs arising from very large tubercles. Spiracles brown.

### *Second Instar*

Head height .9 mm.; head width 1.0 mm. Shiny black.

Bears two prominent dorsal spines. Each spine 1.4 mm. long. Club-shaped and bears long and short black hairs (Fig. 10). The long hairs are serrate. Body 6 mm. long. Shiny transparent, diamine brown. Anal segment frequently yellowish. Body later becomes dark shiny Danube green except for the last two segments. There are no conspicuous spines on segment one. Segments two and three have but one spine in the pleural region in addition to para-dorsal spines. The mid-dorsal spines are lacking. The remaining segments bear mid-dorsal, para-dorsal, suprastigmatal, and infrastigmatal spines. The anal segment bears two mid-dorsal spines. All these spines are black.

*Third Instar*

Head height 1.3 mm.; head width 1.5 mm. Shiny black. Club-shaped dorsal spines 3 mm. long. Hairs longer and more numerous. Body length 10 to 13 mm. Body exceedingly dark chocolate to shiny black. Para-dorsal row of spines possesses large orange, fleshy bases (Fig. 2). Otherwise no change from preceding instar.

*Fourth Instar*

Head height 1.8 mm.; head width 2.0 mm. Dorsal spines now 6 mm. long. Body length 15 to 19 mm. No noticeable change from previous instar.

Eggs laid singly on the underside of leaves of *Blechum blechum* on May 4 emerged four days later on May 8. The butterfly oviposited only on seedlings. The young larvæ ate the entire egg shell and for the duration of the first instar ate the epidermal hairs of the food plant. The first instar was of three days' duration with moulting occurring May 11. The second instar required three days and the third, four days.

### **Anteos clorinde nivifera** Fruhstorfer

*Egg*

Color varies from very light greenish to yellowish. It may be white. Length 1.5 mm. Greatest diameter .45 mm. There are on the average fourteen longitudinal ribs. Only every other one extends to the tip of the egg. All are joined by many parallel cross striations which at the apex of the egg form the micropyle rosette. The end of the egg bearing the micropyle is acute as compared with the base.

*First Instar*

Head height .4 mm.; head width .25 mm. Head entirely colorless and transparent except for the black pigment of the ocelli. Bears a few long transparent hairs. Surface microscopically rugose. Body 4 mm. long. Light greenish yellow. Green from gut clearly visible. Numerous long colorless hairs. Body surface microscopically rugose.

*Second Instar*

Head height .7 mm.; head width .5 mm. Body length 6 mm. Very similar to previous instar. Surface of head and body rougher. Hairs shorter and more numerous. Color same. Some individuals darker yellow.

*Third Instar*

Head height 1.0 mm.; head width .8 mm. Body 9 to 11 mm. long. Very similar to preceding instar. Hairs on head and body still shorter and more numerous.

*Fourth Instar*

Head height 2.0 mm.; head width 1.7 mm. Yellowish green. Surface rugose. Body length 12 to 20 mm. All parts of the body above the stigmatal line are pea green. There may or may not be many indistinct pink transverse lines. The whole dorsal area of the body is studded with minute black hairs arising from conspicuous tubercles. The proportion of black to yellowish tubercles varies considerably but in all specimens there are exceptionally large black and occasionally iridescent tubercles just above the stigmatal line. Stigmatal line and spiracles yellow. Substigmatal areas light yellow with yellowish to colorless hairs arising from tubercles of similar color. The hairs on the head arise from the same kind of tubercles.

*Fifth Instar*

Head height 3.5 mm.; head width 3.0 mm. Yellowish green. Covered with many tubercles of the same color from which arise concolorous hairs. Edges of mandibles fuscous. Black pigment of ocelli visible. Body 35 mm. long. Spiracles cream to white in color. Dorsal areas of body clear light pea green covered with microscopic blackish hairs arranged more or less in transverse rows on the tops of the transverse folds of each segment. Hairs arise from prominent tubercles. Lemon yellow interrupted suprastigmatal line very thin. Wide stigmatal line whitish green. Below the stigmatal line the body is lighter green. The numerous hairs are longer and more lightly colored. Just dorsal to the stigmatal line is an irregular line of black to iridescent tubercles of various sizes. They are most numerous on the thoracic segments, least numerous on the anal segments. Legs and prolegs light transparent green. Tips of claws on legs slightly fuscous.

*Chrysalis*

Length 32 mm. Very light green to yellow. The anterior end terminates in a long thin club-shaped tip. In color this is burnt sienna. From it extend two lateral lines of the same color. Each extends along the dorsal edge of the wing pad then continues as a suprastigmatal line. A mid-dorsal line of similar color passes from the first abdominal segment to the tip of the shallowly bifurcate cremaster. Edges of eyes same color. Body smooth with no prominent hairs or tubercles. The chrysalis is very stout-bodied in the thoracic region bulging considerably ventrally and slightly laterally. It is suspended in the manner characteristic of Pieridæ and Papilionidæ with a girdle around the thorax.

Oviposition is most frequent in the late forenoon and early afternoon. The butterflies circle around large bushes of *Cassia spectabilis,* deposit a single egg, then another a few feet away. One insect may lay as many as fifteen eggs on a single bush at one visit and repeat the performance at a subsequent visit. Each egg is laid singly on the edge of the leaf. It is fastened by its blunt base but reclines on its side. Eggs laid May 4 hatched four days later on May 8. Each instar requires on the average four days. One larva which pupated May 5 emerged May 14, nine days having passed.

## **Nathalis iole** Bdv.

*Egg*

Characteristically pierid in shape. Length .6 mm. Greatest diameter .27 mm. Longitudinally ribbed. Often as many as thirty ribs. The ribs are connected by faint cross stripes approximately .03 mm. apart. Usually not parallel. The color of the egg at the time of oviposition varies considerably. In one case a freshly laid egg lemon yellow in color was followed fifteen minutes later by one in which the larva was clearly visible through the colorless transparent shell.

### *First Instar*

Head height .2 mm.; head width .28 mm. Head smooth, shiny black with few short pale hairs. Body length 1.5 mm. deep turtle green. Few long fuscous spatulate hairs scattered over body. Arise from large rounded tubercles. Two para-dorsal, red, fleshy protuberances on prothoracic segment. Each crowned with a rounded shiny black spine.

### *Second Instar*

Head height .8 mm.; head width .9 mm. Head black to dark brown. Bears many short tapering hairs, colorless to light fuscous. Body length 4 mm. Prothoracic protuberances now bear several short hairs on their sides. Spatulate hairs of body now much shorter. Tubercles from which they arise relatively larger. Each segment now bears in addition to the spatulate hairs a pair of blunt shiny black hairs paradorsally, laterally, and in the suprastigmatal position. All arise from prominent tubercles. Body dark greenish glaucous with dark green mid-dorsal line and light green to white stigmatal line.

### *Third Instar*

Very little change from previous instar. Head light green.

### *Fourth Instar*

Similar to third instar. Head green to greenish yellow.

### *Fifth Instar*

Head height 1.2 mm.; head width 1.2 mm. Head light green to yellow. Otherwise not much change. Body length 17 mm. There is a wide variation in the coloring of the larva. The shade of green varies. Some larvæ were grass green while others were dark greenish glaucous. Some possess a darker green mid-dorsal line while others have a bright red interrupted line. The stigmatal line ranges from light green to white. Numerous colorless hairs arise from prominent warts. The body is microscopically mottled with the warts arising from dark green areas. Areas between are lighter green. The blunt shiny hairs of the second instar are much reduced and not easily distinguishable from the other hairs of the body. Short fuscous hairs on the head. Head surface finely granular.

*Chrysalis*

Length 6.5 to 10.8 mm. Typically pierid-shaped. Dark greenish glaucous. Mottled with light and dark green. Just prior to emergence the dark green mottling assumes a light fuscous appearance. On the wing pads this is in the form of dendritic more or less parallel lines in the same direction as the veins. Those on the tongue case are at right angles to the axis of the tongue. Fewer on abdominal segments; none in intersegmental areas. Absent on dorsal side of abdomen except for an irregular para-dorsal row of splotches. Markings increase laterally and ventrally. Surface smooth. Cremaster blunt. Spiracles rimmed with fuscous. Mouth-parts and especially antennæ are frequently outlined in fuscous.

Eggs were laid May 29 and 31. Some hatched two days later. The duration of the different stages of this species varies extremely. Color markings also show a wide variation. Each instar may require from three days to a week or ten days. The pupal stage requires an average of seven days. Females have never been observed ovipositing earlier than nine o'clock in the morning. Eggs are laid on very small seedlings of *Bidens leucantha.* Many false starts are made before an egg is actually laid. A female may visit several seedlings and at each one go through the motions of oviposition without extruding an egg. Then she may lay several eggs in rapid succession each on a different seedling.

### **Eurema lisa** (Bdv. & LeC.)

*First Instar*

Head height .28 mm.; head width .3 mm. Head transparent and nearly colorless. Smooth with few hairs. Length of body 1.7 mm. Transparent yellow. Green in gut visible. Longitudinal rows of rather long fuscous tapering hairs.

*Second Instar*

Head height .58 mm.; head width .6 mm. Head same color. Smooth. Numerous short fuscous hairs over entire surface. Length of body 4 to 5 mm. Same color as before. Mid-dorsal line dark green. Stigmatal line light green. Numerous short black hairs arising from whitish tubercles. Those on anal segment longest.

*Third Instar*

Head height .9 mm.; head width 1.0 mm. Length of body 5 to 8 mm. Mid-dorsal line Danube green. Para-dorsal line shamrock green. Narrow stigmatal line light turtle green. Remainder of body clear fluorite green. Other characters same as above.

*Fourth Instar*

Head height 1.4 mm.; head width 1.5 mm. Head smooth. Fuscous hairs shorter and more numerous. Length of body 10 to 13 mm. Same as above.

Eggs laid May 31 hatched June 3 three days later. They were laid on the leaves of *Mimosa pudica*. The female deposited the eggs most often on the top side of the vein of the leaf. She was not disturbed by the action of the plant which closed its leaflets against her abdomen. Upon withdrawal of the abdomen the eggs were hidden from sight.

### **Papilio celadon** Lucas

*Egg*

Greatest diameter 1.0 mm. Height .9 mm. Light green in color. Nearly spherical. Surface smooth except for a faint reticulation forming microscopic polygonal areas. Food plant not determined.

### **Papilio polydamas** L.

*First Instar*

Head height 1 mm.; head width 1 mm. Head smooth, chocolate. Few short black hairs. Length of body 3 to 6 mm. Body light chocolate. Covered with minute whitish hairs simulating a pubescence. Larger black hairs on legs, anal segment, and slightly protruding substigmatal areas. Spiracles, legs, and thoracic shield dark chocolate. A row of para-dorsal fleshy protuberances. Those on segments one, seven, nine, and twelve, yellow to light orange. Covered with whitish pubescence. Others more darkly colored with chocolate. Prothoracic pair longest.

*Second Instar*

Head height 1.5 mm.; head width 1.8 to 1.9 mm. Little change from previous instar. Color similar. Fleshy processes longer and brighter yellow. Body length 12 mm.

*Third Instar*

Head height 2.5 mm.; head width 2.8 to 3 mm. Head darker chocolate than preceding instar. Body length 18 mm. Darker chocolate. Processes brighter orange. Those on segments one, two, and three are at the stigmatal line. That on segment four is at the suprastigmatal line; that on segment five, substigmatal. All segments, the first excepted, bear the usual para-dorsal processes. Small pale processes at the bases of all the legs. Those on segments ten and eleven most prominent. All are clothed with microscopic fuscous to black hairs.

*Fourth Instar*

Head height 3.7 mm.; head width 3.9 mm. Head light chocolate early in instar but later becomes shiny black. Body length 22 mm. Dorsal anterior side of prothoracic processes chocolate. Long and tapering. Tips of remaining processes clothed with black hairs. Body chocolate. Dorsal, and to smaller extent, ventral side striped transversely with narrow deep crimson bands.

*Fifth Instar*

Head height 4 mm.; head width 4.4 mm. Length of body 27 mm. Similar to preceding instar.

Each instar required from three to five days. The average life cycle required thirty days. Larvæ which hatched May 1 pupated May 21. The pupal stage lasted ten days. As food plant *Aristolochia argyreoneuron* was preferred, but the following species were eaten to a varying degree: *A. ringens*, *A. forckelii*, *A. redicula*, *A. saccata*, *A. tagala*, *A. fimbriata*, *A. brasiliensis*, *A. cymbifera*, *A. elegans*, *A. gigantea*, *A. grandiflora*, *A. glandulosa*, *A. hians*, *A. indica*, *A. Kaempferi*, *A. Roxburghiana*, *A. Ruiziana*, and *A. trilobata*.

### **Hemiargus filenus** Poey

*Egg*

Pale dull glaucous-blue. Greatest diameter .4 mm. Height .15 mm. Top surface noticeably concave. Surface with macroscopic polygons formed by a greatly raised reticulation. Polygonal areas further divided into microscopic polygons raised but little above the general surface.

*First Instar*

Head height .1 mm.; head width .15 mm. Head smooth shiny black. Usually retracted. Length of body .9 mm. Clear light green. Long tapering colorless hairs on body. Para-dorsal and substigmatal rows longest. Hairs usually directed posteriorly.

Eggs laid on *Mimosa pudica* May 29, 31, and June 1 emerged June 3, 4, and 5. The duration of the egg stage was usually five days. Eggs were laid most frequently at the base of a bud. As with *N. iole* the female made many false starts. An egg would be laid every ten to fifteen trials.

### **Pyrgus syrichtus** Fabr.

*Egg*

Cream color.

*First Instar*

Head height .4 mm.; head width .42 mm. Smooth shiny piceous, with few rather long whitish hairs. Length of body 1.5 mm. Body bears many colorless to fuscous hairs. Those on the prothoracic and anal segments are the longest and of the usual tapering type. Hairs forming the para-dorsal, lateral, and stigmatal lines are branched (Fig. 4). Those below the stigmatal line are of the usual tapering type. Body cream color.

Eggs laid May 22 emerged five days later May 27. Although *Sida* is listed as the food plant of these larvæ, several local species of *Sida* were refused by the larvæ which eventually died.

### **Cabares potrillo** (Lucas)

*Egg*

Dark pea green. Greatest diameter .8 mm. Height .78 mm. Eleven prominent longitudinal ribs. These connected by low cross striations (Fig. 7). Eggs failed to hatch. Food plant unknown.

## LITERATURE CITED.

Davenport, D. and Dethier, V. G. 1938. Bibliography of the described life-histories of the Rhopalocera of America north of Mexico 1889-1937. Entomologica Americana, 27 (4): 155-194.

Ridgway, R. 1920. Color standards and color nomenclature. Washington, D. C.

## EXPLANATION OF PLATE III.

Fig. 1. Second instar head capsule of *Calisto herophile* Hbn. Approximately x 50.

Fig. 2. Para-dorsal spine of third instar *Metamorpha stelenes insularis* (Holland). x 35.

Fig. 3. First instar head capsule of *C. herophile* Hbn. x 33.

Fig. 4. Branched hair of first instar *Pyrgus syrichtus* Fabr. Approximately x 200.

Fig. 5. Egg of *C. herophile* Hbn. Approximately x 18.

Fig. 6. Same.

Fig. 7. Micropyle rosette of egg of *Cabares potrillo* (Lucas). x 35.

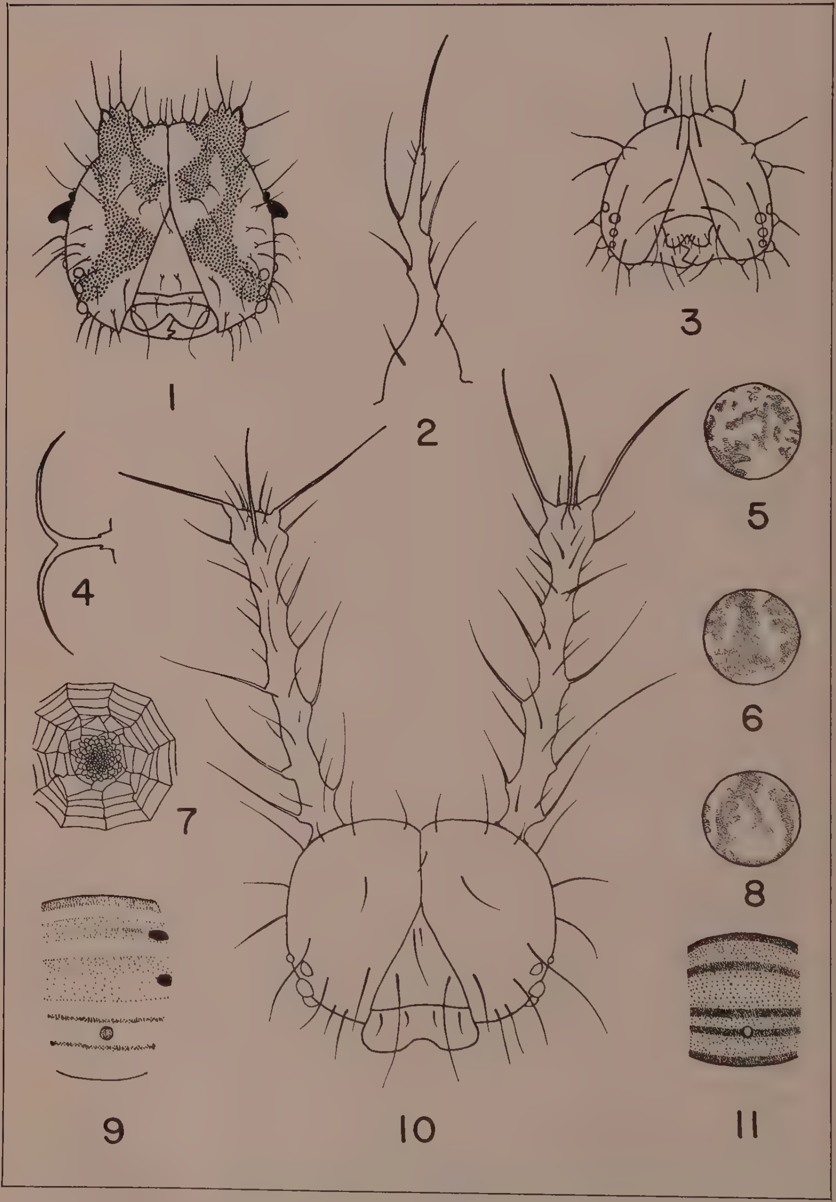
Fig. 8. Same as Figs. 5 and 6.

Fig. 9. Diagrammatic representation of the color pattern on an abdominal segment of the third instar larva of *C. herophile* Hbn. Approximately x 16.

Fig. 10. Second instar head capsule of *M. stelenes insularis* (Holland). x 35.

Fig. 11. Diagrammatic representation of the color pattern on an abdominal segment of the first instar larva of *C. herophile* Hbn. Approximately x 16.

Psyche, 1940 VOL. 47, PLATE III.



Dethier — Cuban Lepidoptera

# THE CONOPIDAE OF THE WEST INDIES AND BERMUDA (DIPTERA).

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No Conopidæ have been recorded from Bermuda and only three species from the West Indies. Of these three species, one is almost certainly incorrectly identified, and the second has always been placed as a synonym of the third. In this paper the synonymized name is resurrected and six species are described as new. Since the members of the Conopidæ are usually widely distributed, comparisons were made with the entire New World fauna.

The origins of the West Indian Conopidæ are obscured by the scarcity of data, since no representatives are yet known from Jamaica or the Lesser Antilles. Trinidad, from which Kröber has recorded *Physocephala testacea* v.d. Wulp (Argentina), is usually regarded as part of South America. The *Conops* herein described from Bermuda is so distinctive that nothing can be said concerning its relationships. No true *Conops* are yet known from the West Indies, but the Antillean *Physoconops* and *Zodion* show more or less definite affinities with Middle or South American forms. The unique *Physocephala* seems to be closely allied to a Costa Rican variety of a widely distributed South American species. The single *Occemyia* represents the first southern extension of the genus from the Nearctic region. The predominantly South American aspect of the West Indian Conopidæ is consistent with the fact that the Nearctic forms strongly indicate a Neotropical origin.

## **Conops** Linnaeus

Linnaeus, 1758, Syst. Nat., p. 604, no. 226.

True *Conops* (*s. str.*) occurs generally throughout the

New World, but so far has not been found in the West Indies.

**Conops bermudensis** new species (Fig. 3)

Female: length 7 mm. Easily recognized by its dark color, entirely yellowish wings, and black spot in front of each eye. Front and vertex dark reddish brown; cheeks somewhat paler; face testaceous; a round, black, velvety spot in front of and contiguous with each eye at a level with the base of the antennæ. Fine silver pollen on face and cheeks and extending up to the black spot. Basal segments of antennæ dark brown, more than three times as long as wide; other segments missing. Proboscis dark brown, darker towards the apex, twice the length of the head. Thorax dark brown, obscurely covered with very fine silver pollen; mesonotum (except the humeri) black; scutellum dark brown; metanotum black. Legs dark brown; tibiæ becoming darker towards their apices; tarsi dark piceous; pulvilli and claws pale testaceous; tips of claws black. Coxæ covered with very fine silver pollen. Abdomen dark brown, covered with very fine silver pollen, particularly on the sixth and seventh segments. Ventral plate rather long, very convex and broad. Wings entirely uniformly pale yellowish brown.

Holotype (♀): Bermuda (Owen Bryant); in the Museum of Comparative Zoology.

The specimen is in rather poor condition, but is worth describing because it represents the first Conopid to be found in Bermuda. Most of the Nearctics species heretofore described under *Conops* really belong in *Physoconops.* But *bermudensis* is a true *Conops* and so distinctive that it cannot be confused with any other species.

**Physoconops** Szilady

Szilady, 1926, Annal. Mus. Nat. Hungar., 24: 588.

**Physoconops cubanus** new species (Figs. 6, 7)

Female: length without antennæ 10.5-11 mm. Front dark testaceous, vertex and median line, extending to the antennæ, piceous. Face and checks testaceous; anterior and posterior orbital margins covered with golden pollen. Proboscis dark piceous, apex black; less than twice the length of the head. Antennæ as figured, dark piceous, proximal segment paler. Thorax black; humeri brown with the inner side covered with golden pollen; also golden pollen on the mesonotum surrounding the humeri and on the mesopleuræ and sternopleuræ. Scutellum either black or with obscure golden pollen. Metanotum black, anterior half covered with golden pollen; most of metapleuræ covered with golden pollen. Halteres testaceous. Legs testaceous, tarsi black except at their proximal ends. Anterior surface of anterior coxæ and outer surfaces of fore and middle tibiæ covered with golden pollen. Pulvilli and claws testaceous, tips of claws black. Abdomen as figured; segments one and two black, with golden pollen on the posterior margins; the third segment with an obscure proximal yellow band; segments apical to two are dark rufous. Ventral plates of medium length and definitely narrowed at the tip, black on the posterior side. Wings hyaline with reddish brown band becoming fuscous at apical half. The dark band is paler in the costal cell; extends posteriorly to the first basal cell, to the vena spuria, and to a narrow hyaline margin in the distal half of the first posterior cell, but filling out the cell at its apex.

Male: length without antennæ 12 mm. Similar to the female but the golden pollen almost absent in the only specimen. The yellow band at the base of the third abdominal segment broader and more distinct than in the female.

Holotype (♀): Sept. 2, 1930, Guabairo about 4 miles north of Soledad, near Cienfuegos, Cuba (Richard Dow); allotype and paratype (♀) with same data as holotype; in the Museum of Comparative Zoology.

In Kröber's key (1939, Ann. Mag. N.H., 4: 467) *cubanus* runs to *fronto* Will. but differs in having a relatively longer third antennal segment, and differently colored thorax, front, occiput, and abdomen. In Van Duzee's key (1927, Proc. Calif. Ac. Sci., 16: 578) *cubanus* runs to *gracilis* Will., but *gracilis* is a true *Conops*.

### **Physoconops bahamensis** new species (Figs. 8, 9)

Female: length without antennæ 13 mm. Vertex piceous with a black center; front testaceous becoming piceous or black at its upper margin. Face and cheeks pale testaceous; the facial depression and orbital margins with golden pollen. Antennæ as figured, piceous, the second segment thickly setaceous. Proboscis rufo-testaceous, tip piceous, less than twice as long as the head. Thorax black, a silver pollen spot on the inner side of each humerus and extending to the base of each wing. Anterior half of the scutellum, metanotum, and metapleuræ covered with silver pollen. A silver pollinate band on mesopleuræ and sternopleuræ. Anterior surface of prothoracic coxæ covered with golden pollen, the other coxæ with silver pollen. Femora bright rufo-testaceous; tibiæ pale testaceous, the proximal halves very pale; tersi black, paler at their proximal ends; pulvilli and claws pale yellow, tips of claws black. Halteres pale yellow. Abdomen as figured; first segment black, rest of the abdomen black. The posterior margins of the first, second, and third segments with silver pollen. The dorsal surface of the sixth segment covered with silver pollen. Fifth segment strongly constricted; the ventral plate very long. Wings with yellowish brown band in veins 1-5, except that the apical half of the second posterior cell is hyaline, and a narrow band along the posterior margin of the first posterior cell (except at the extremity) is hyaline. The brown band becomes fuscous at the apical third of the wing.

Holotype (♀): February 8, 1934, Eleuthera Island, Bahama Islands (Utowana Expedition) in the Museum of Comparative Zoology.

It is difficult to see what are the relationships of this species. In the key just published by Kröber (1939, Ann. Mag. N.H., 4: 466-467) *bahamensis* might run to *rufipennis* Macq. or *discalis* Will., depending on how one interprets the color of the wings. Macquart's species, however, has a differently colored head, scutellum, tarsi, and abdomen. Williston's *discalis* has a much shorter third antennal joint, black front, and other differences. Of the North American species, *bulbirostris* Loew is perhaps closest.

### **Physoconops ramondi** (Bigot) (Figs. 1, 2)

*Conops ramondi* Bigot, 1857, in Ramond de la Sagra's Cuba, vol. 7, p. 808; pl. 20, fig. 6.

*Conops pictus* Fab. of authors, in error.

Female: length without antennæ 21 mm. Easily distinguished by its very large size and reddish brown color. Front, face, cheeks reddish brown. There is yellow pollen in the facial depression and extending along the facial and posterior orbits up to a little above the level of the base of the antennæ. In certain angles of light the pollen shows as a golden sheen. Proboscis reddish brown, evidently less than twice the length of the head (in the single female the apex is broken off). Antennæ as figured; reddish brown, style paler, second segment thickly covered with black setæ. Thorax reddish brown, a pair of obscure longitudinal piceous lines on anterior part of mesonotum and one near each margin of the mesonotum. Humeri without pollen, but an irregular golden pollen spot on the inside of each humerus and posterior from the humeri to the wing bases. An oblique golden pollen band on the mesopleuræ and sternopleuræ. Golden pollen hardly discernible on the reddish brown scutellum but forming a yellow band across the anterior half of the metanotum. Halteres dull yellow. Legs pale reddish brown, coxæ covered with a silvery yellow sheen; distal halves of the tibiæ covered with a yellow sheen, especially on the outer side; tarsi black, pale at each end; tips of claws black. Abdomen as figured; reddish brown; the posterior margins of the first and second segments with golden pollen, particularly on the sides; two obscure piceous stripes on the second segment; ventral plate very long, black on the posterior side. Wings hyaline, with a reddish brown streak from the first to the fourth veins, tending to be fuscous distally; posterior part of first posterior cell and most of the second posterior cell hyaline.

Male: length without antennæ 20.5 mm. Similar to the female but the style much longer and more attenuate; proboscis darker, with a black tip; first to third abdominal segments much thinner, and more pollen on the scutellum.

Described from a pair collected by C. T. Ramsden in 1910 (♂ May 31, ♀ June 21) on the Rio Seco, Quantanamo, Cuba in the C. W. Johnson collection of the Museum of Comparative Zoology.

Osten Sacken, in his catalogue (1878, p. 255), quotes Loew as stating *in litt.* that *ramondi* is the same as *pictus* Fab., and as a result of Loew's dictum *ramondi* has remained a synonym to this day. Since *ramondi* is twice the size of *pictus* and accurately figured in color by Bigot, it is inconceivable how Loew made such a statement. The specimens described above, however, were correctly named by Johnson.

### **Physoconops pictus** (Fabricius)

*Conops picta* Fab., 1775, Syst. Ent., 4: 391 (West Indies).
*Conops ramondi* Bigot of authors, in error.

This species appears to be restricted to the West Indies. Macquart recorded it from the United States ("Carolina") and Weidemann from South America, but these references are almost certainly to other species. In the Museum of Comparative Zoology there are specimens from Cuba, Haiti, and Puerto Rico. The American Museum of Natural History also has specimens from Cuba and Puerto Rico. Kröber, 1939, records *pictus* from "S. Domingo".

Another species, for which good structural differences cannot at present be found, is represented in the Museum of Comparative Zoology by two specimens labelled "Cuba", one from "Havana, Cuba, Baker", and one from Buenos Aires, Trinidad Mts., Cuba, June 17-23, C. Parsons. This species differs from *pictus* in having a dark rufous abdomen, black scutellum, etc. It is perhaps intermediate between *pictus* and *cubanus*.

### **Physocephala** Schiner

*Physocephala* Schiner, 1861, Wien. Ent. Monatssch., 5: 137.

### **Physocephala venusta** new species (Figs. 12, 13)

Female: length without antennæ 9.5 mm. Face and front yellow except for a sinuous rufo-piceous transverse band contiguous with the vertex and extending medially down to the antennæ but not divaricating at the antennæ. Antennæ as figured, rufo-testaceous, the third segment and style somewhat paler, the distal end of the first and dorsal and lateral sides of the second segment covered with black setæ. Cheeks pale piceous with an obscure testaceous spot. Silvery white pollen extends along the eyes half way up the front. Proboscis dark piceous, about twice as long as the head. Mesonotum black, surrounded by a margin of gold pollen, except at the median third on the anterior margin. Sides of the thorax dark rufo-piceous with an irregular oblique band of golden pollen. Scutellum black; metanotum black with a large spot of golden pollen on each side. The halteres pale yellow. Coxæ dark rufo-piceous covered with coarse silvery pollen; trochanters and bases of the femurs pale testaceous; femora dark piceous except about the distal fourths, which are pale testaceous; tibiæ and tarsi pale testaceous, tips of claws black. Abdomen as figured, rufo-piceous tending to be darker dorsally and towards the base of each segment. Posterior margins of the segments with obscure golden pollen; except for a broad patch on each side of the distal end of the first segment and generally on the dorsal surface of the sixth segment. The ventral plate rufo-testaceous, black from behind, when seen from below angulate, forming an angle of 120°. Wings subhyaline, costal and subcostal cell testaceous; the usual brown stripe extends from the first vein to fifth, slightly beyond the apex of the second posterior cell, and does not fill up completely the first posterior cell.

Holotype (♀): Nov. 16-17, 1934, Mannville, Haiti (P. J. Darlington, Jr.) in the Museum of Comparative Zoology.

Of the Nearctic species *venusta* is clearly nearest to *sagittaria* Say. But *sagittaria* is larger, has a longer style, longer second antennal joint, the median black frontal line divaricating at the antennæ, larger and more rounded ventral plate, and color differences.

A Neotropical species which appears to be very closely related to *venusta* is *bimaculata* Kröber, described, from Argentina, Ecuador, and Colombia. According to Kröber's description (1915, Archiv. f. Naturgesch. Abt. A, H. 4, p. 140) *bimaculata* is much larger, has a shorter second antennal joint, scutellum reddish brown instead of black, abdomen black with much more yellow, and the ventral plate larger and rounded, not angulate. Kröber (Konowia, 5: 130) gives a supplementary description and figures of *bimaculata* from Costa Rica. The figures show that *venusta* is near but distinct from *bimaculata.*

### **Zodion** Latreille

*Zodion* Latreille, 1796, Préc. des caract. gen. d. Ins., p. 162.

### **Zodion canescens** new species (Figs. 4, 5)

Female: length 5 mm. Face yellow with the depressed central portion piceous; a few fine pale hairs on the cheeks, longer and darker hairs on front and vertex; front piceous, becoming darker towards the vertex; shining space around the ocelli broadly angular anteriorly. Face and cheeks covered with pale yellow pollen. Antennæ as figured, first and second segments piceous, the third rufo-testaceous. Proboscis twice as long as the head. Thorax piceous, covered with grey pollen except for three broad dorsal longitudinal piceous lines. The legs piceous but the femora, except at their distal ends, and tibiæ more or less feebly covered with grey pollen. Halteres yellow; calypteres white. Wings subhyaline, veins piceous, first posterior cell broadly closed. The abdomen as figured, segments one to four and all but the posterior margin of the fifth black, covered with grey pollen, except along two broad dorsal bands. The apical segments and ventral plate are rufo-testaceous.

Holotype (♀): April 12, 1926, Soledad, near Cienfuegos, Cuba in the American Museum of Natural History.

Among the North American species *canescens* is closely related to *fulvifrons* Say. But *fulvifrons* has a broad low ventral plate, longer proboscis, paler front, etc. Among the Neotropical species *canescens* is apparently very near to *americanum* Wied. According to Kröber, who examined the male type from Uruguay, *americanum* differs in having a pale front, proboscis more than twice the length of the head, two narrow black lines on the thorax, differently marked and colored abdominal segments. Kröber says that a female, without a head, next to the type is identical with *nanellum* Loew. If this is so, then the anal segment and ventral plate of *americanum* is very different from *canescens*.

### **Zodion species** *vix* **americanum** Wied.

In the U. S. Nat. Museum is a Zodion from San Diego de Los Banos, Pinar del Rio, Cuba which is labelled *americanum* Wied. Unfortunately it is a male, but it seems to be much closer to *canescens* than to *americanum*. Roeder (1885, Stett. Ent. Zeit., 46: 343) records *americanum* from Puerto Rico, but very likely it is not true *americanum*.

### **Occemyia** Robineau-Desvoidy

*Thecophora* Rondani, 1845, Nuovi Annali d. Sci. Nat., 3: 15

*Occemyia* Robineau-Desvoidy, 1853, Dipt. Eur. Paris, Myop., p. 50

*Oncomyia* Loew, 1866, Berlin ent. Zeit., 10: 41 (emend. of *Occemyia*)

*Thecomyia* Brues and Melander, 1932, Bull. M.C.Z., 73: 306 (*lapsus calami*).

All writers except Coquillett have overlooked the 1845 description of *Thecophora*. They cite the 1857 description, but even so Rondani's name is preoccupied by Charpentier's use of it for a subgenus of Odonata (1840). Since Charpentier's name was *Thecaphora* a strict application of the rules would necessitate the use of Rondani's *Thecophora*. It may be argued, however, that Rondani's name is invalid since he did not clearly indicate a species with the genus. *Thecomyia* (Tetanoceratidæ) was a slip for *Thecophora*.

### **Occemyia haitiensis** new species (Figs. 10, 11)

Female: length 4 mm. Shining dark piceous, except the following parts which are more or less pale testaceous; face, cheeks, lower half of antennæ, basal half of inner side of third antennal joint, halteres, calypters, anterior surface of front coxæ, basal half of hind femora, narrow base of four anterior femora, distal tips of femora and bases of tibiæ, extreme tips of tibiæ and basal joints of tarsi. Front between vertex and base of antennæ rufo-testaceous. The shining space around the ocelli extends downward in an acute point. Front, occiput, thorax and abdomen with quite long black hair. Posterior lateral third of second abdominal segment and posterior margin of next two segments with silvery pollen. The hairs at the extremity of the abdomen somewhat pale. Each cheek with a group of about four very short black hairs and along each oral margin a row of black hairs which are about as long as the first antennal segment. Cheeks with silvery white pollen, which extends narrowly to top of eye on the frontal orbit and to the middle of the eye on posterior orbit. Antennæ as figured. Palpi small and piceous; proboscis with apical segment in the female a little shorter than the first, unknown in the male. Ventral plate of female narrow and rather long, shining piceous. Veins of wings uniformly piceous but becoming paler at the base.

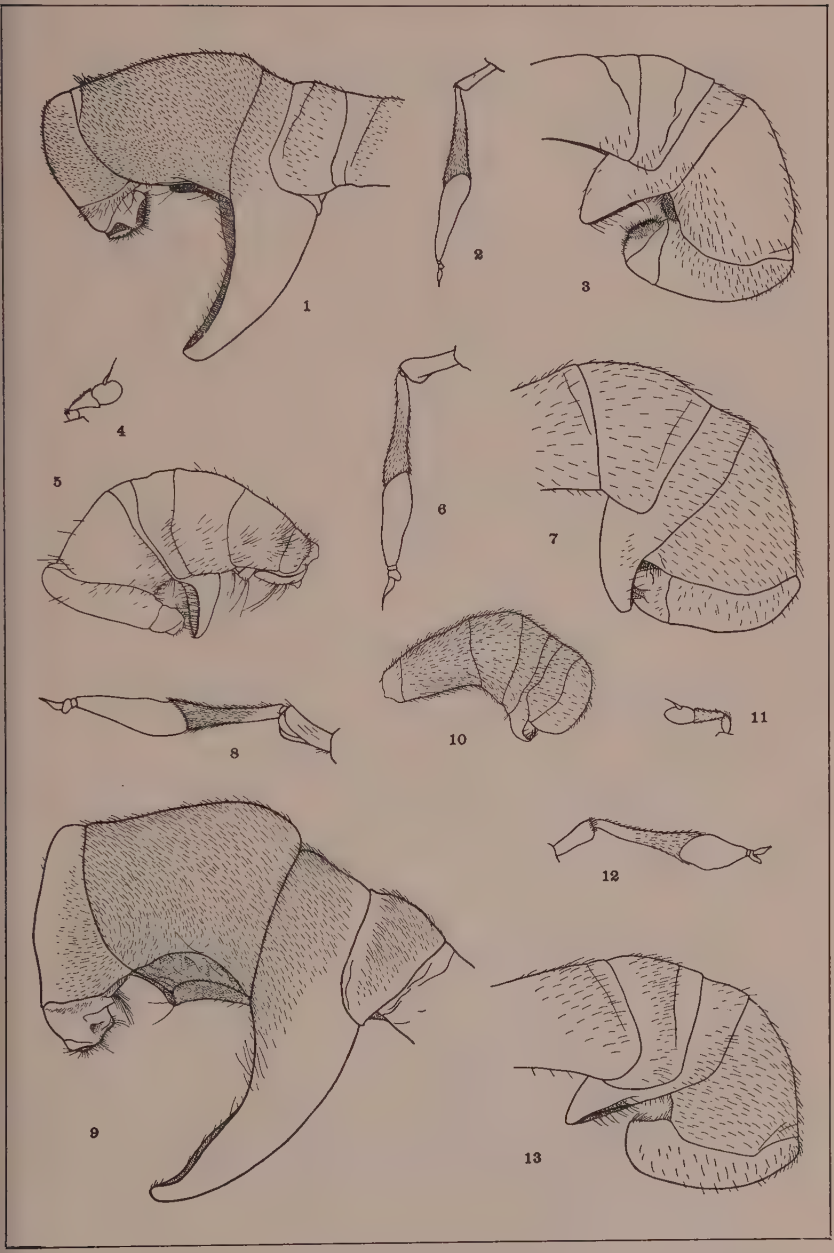
Holotype (♀): Port-au-Prince, Haiti (William Mann) in the Museum of Comparative Zoology.

In Van Duzee's key *haitiensis* runs to *nigra* Van Duzee from Oregon. But it differs from *nigra* in the shape and color of the antennæ, the pale hairs on the abdomen, darker front, the relative lengths of the first and second segments of the proboscis, etc. The new species is perhaps nearest to *loraria* Loew from eastern United States. But *loraria* has a shorter ventral plate, paler front, and dark hairs on the cheeks absent or very few and fine.

## EXPLANATION OF PLATE IV.

Figs. 1-13: Antennæ and abdomens of female Conopidæ. All are enlarged the same amount, except *P. ramondi* which is enlarged half as much as the others. 1, 2: *Physoconops ramondi;* 3: *Conops bermudensis;* 4, 5: *Zodion canescens;* 6, 7: *Physoconops cubanus;* 8, 9: *Physoconops bahamensis;* 10, 11: *Occemyia haitiensis;* 12, 13: *Physocephala venusta.*

Psyche, 1940 Vol. 47, Plate IV.



Parsons — Conopidæ

# FOOD PREFERENCES OF THE COLORADO POTATO-BEETLE, *LEPTINOTARSA DECEMLINEATA* SAY.

By Charles T. Brues

Biological Laboratories, Harvard University

The experiments[1] here described were undertaken some years ago (1923-25), but no account of them was published at that time as a report on work of a somewhat similar nature by others appeared while my own was still in progress. More recently one or two additional papers relating to the choice of food-plants by the Colorado potato-beetle have been published and the whole question appears worthy of review with incorporation of the data secured by the present writer.

Aside from its importance as an insect pest of cultivated potatoes the Colorado potato-beetle is of particular interest on account of an apparent shift in its food-habits which occurred less than a century ago when it was first noted as feeding on the foliage of the potato. However, the food preferences of this beetle are not so clear as might appear from this statement and they have already furnished interesting material for study at the hands of several entomologists in this country and in France where the species has been naturalized since about 1920.

The potato-beetle was described by Thomas Say in 1824 from the western plains region and was regarded by him as native to the United States. There seems to be no reasonable doubt that this supposition was in error and that the original habitat was Mexico. At the time of its discovery by Say and for several decades later the beetle appears to have restricted its feeding to the foliage of a common weed of the Southwest, *Solanum* (*Androcera*) *rostratum*. This plant in turn is of Neotropical origin and is thought to have preceded the beetle, and to have become naturalized in the United

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[1] I wish to express my gratitude to the Elizabeth Thompson Fund for a grant which made possible the construction of a series of large outdoor cages in which the breeding experiments were conducted.

States at a much earlier date. Its spread may have followed the trails of the early Spanish explorers aided by the bur-like fruit which is readily transported on the fur of animals or clothing of man. Later this plant became more sparingly naturalized further northward and eastward under locally arid conditions like those prevailing on waste land or railroad ballast. That this plant may be actually native to the drier parts of our southwestern states is quite possible, but at any rate it appears to have been the preferred food-plant of the potato-beetle during the earlier half of the nineteenth century. There is also a native potato in this same region, *Solanum fendleri* Gray, *nec* Heurck & Muel. (*S. tuberosum boreale* Gray) which extends from Western Texas to Arizona and Mexico in moist transition areas but there are apparently no records that indicate whether or not this wild potato has ever served as a food-plant for the beetle. That it might do so is very likely since it is very similar to the cultivated form, although as the two plants (*S. fendleri* and *S. rostratum*) do not occur under similar ecological conditions passage from one to the other could not commonly occur.

Before 1860 the potato-beetle found a highly acceptable food-plant in the potatoes that were cultivated in the region where it then occurred and it was recognized as early as 1859 as an established pest in gardens. Thenceforth it spread into the eastern and southern states and later to the Pacific region. It has continued to prefer the potato to other species of the genus *Solanum* (*s. lat.*), although several other genera of Solanaceæ are sometimes attacked in a more sporadic way. Thus it is well known that the larvæ are frequently destructive to egg-plants (*Solanum melongena*) in gardens and that they appear occasionally on tomatoes (*Lycopersicum esculentum*), ground cherry (*Physalis* spp.) and on certain varieties of cultivated tobacco (*Nicotiana*) that develop a low nicotine content in the leaves.

The sporadic occurrence of the beetle on some of its less favored food-plants may indicate the presence of separate strains or genetically distinct types, especially as it cannot always be traced to the absence of the preferred potato food-plants in the immediate vicinity.

With this question in mind a series of 24 species of Solanum were secured as seed and plants were raised in the greenhouse. These were then set out in the open[2] at the time the first seasonal brood of beetles appeared and a number of adults (ten) were placed on the foliage of each plant. From these preliminary tests it was at once evident that there was a wide variation in the readiness with which the beetles fed upon the several species of Solanum that were offered to them. Omitting the potato which was suffering heavily from beetle feeding throughout the neighborhood at that time, several species were greedily accepted and voraciously fed upon. Among the species tested these were notably *S.* (*Androcera*) *rostratum*, *S. dulcamara*, *S. melongena* (garden egg-plant), wonderberry[3], *S. marginatum*, and *S. subinerme.*

Several were absolutely refused, including *S. nigrum*, *S. pseudocapsicum*, *S. barbisetum*, *S. granuloso-leprosum*, the garden tomato (*Lycopersicum esculentum*) and three unidentified Panamanian species.

Intermediate with reference to feeding were *S. pyracanthum*, *S. atropurpureum* and an unidentified Panamanian species.

As a result of these preliminary tests nine species were selected for further experimentation, as follows: "wonderberry", *S.* (*Androcera*) *rostratum*, *S. subinerme*, *S. marginatum*, *S. dulcamara*, *S. torvum*, *S. barbisetum*, *S. melongena* and *Lycopersicum esculentum.*

The last-mentioned species was added, although the beetles had previously refused to feed upon it, because of an infestation called to my attention by Professor W. E. Castle, who noticed the familiar beetles and larvæ destroying the

[2] On the grounds of the Bussey Institution at Forest Hills, Boston, Mass. where the entomological laboratories of Harvard University were located at that time.

[3] This plant was secured from a seedsman as Luther Burbank's "Wonderberry" which is according to botanists a form of *Solanum nigrum*. However, as noted below, the potato-beetle does not feed on the wild form of this species and cannot develop on it, a fact also attested by Trouvelot ('33) and his co-workers who attempted unsuccessfully to rear this insect in France on European plants of this cosmopolitan *Solanum*. The wonderberry is said to have originated as a hybrid between *S. villosum* and *S. guineense* (cf. Whitson & Williams, "Luther Burbank," vol. 6, pp. 105-133 (1914). The latter name has been applied to both *S. nigrum* and *S. aggregatum*, so the nativity of the wonderberry is hopelessly shrouded in doubt, but it appears that it is not identical with *S. nigrum* as has been assumed.

foliage of tomato plants in his garden in Belmont, near Cambridge, Mass. On account of this unusual occurrence it appeared that we might have chanced upon a mutation in choice of food and a part of the colony was transferred to one of the large screened cages[4] with a few healthy tomato-plants. They continued to feed and it appeared that some of the larger larvæ had entered the soil to pupate although the majority died before attaining full growth. However, no adults of a second generation appeared in the cage and the soil was left undisturbed until the following summer which likewise brought forth no beetles. This second year a similar infestation occurred in Professor Castle's garden, but we made no further transfers as it was evident that the beetles could not maintain themselves on tomato even though certain adults had developed a taste for it. In France Trouvelot and Thénard ('31) have similarly noted the disappearance of the larvæ from tomato plants and they attributed this to the difficulty experienced by the larvæ in maintaining their foothold while crawling on the coarsely hairy leaf stalks. This has been later questioned, however, by others working in the same region. Feytaud ('23) noted earlier that the adult beetles in France eat tomato foliage avidly, a statement that could certainly not be applied generally to the potato-beetle population in America. Quite recent studies in France substantiate this as they have shown that certain varieties of tomato are readily eaten while others are not.

Laboratory experiments by McIndoo ('35) showed that both adults and larvæ are to a surprising extent attracted to tomato leaves when permitted to choose between potato, horse-nettle (*Solanum carolinense*), *S. dulcamara* and tomato. Although showing much irregularity, a considerable number (±9.6-12%) of beetles and many larva (15%) came to rest on the tomato leaves. As the species is unable to survive on tomato it is clear that when tomato is as readily available as other acceptable species that there is a consistent weeding out in the general population of those beetles that are attracted to tomato. Even granting that the inability to mature on tomato is not absolute it is obvious that natural selection will completely prevent the development of any strain attracted to this plant for oviposition.

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[4] These cages were four feet square at the top and bottom with vertical sides eight feet high, covered completely with bronze window screening except on the bottom which was sunk to a depth of eight inches in the soil of the garden. They thus maintained the plants and insects under practically out-door condition throughout the year.

The relation of the potato-beetle to tomatoes is an extreme case of mistaken instinct, but the broods in our other cages showed that a similar less pronounced relationship prevails with at least some other species of *Solanum*. As mentioned in a preceding paragraph nine species on which the beetles fed readily were set out in separate breeding cages in the spring of 1923. Each cage was supplied with twenty beetles (ten of each sex). No further attention was paid to them except to note the progress of the experiment and to replace from a reserve stock any plants that suffered excessive defoliation. Replenishment was necessary especially in the case of *S. rostratum* as these plants were smaller and appeared to grow less vigorously.

Numerous larvæ developed in all of the nine cages and beetles of a second generation appeared in all of them. Plants were kept growing in the cages until the end of the season and outdoor conditions prevailed during the winter.

The following season (1924) the cages were again supplied with plants of the same species, but, of course, no further beetles were added. Beetles appeared in all but four of the nine cages. These four included *S. marginatum*, *S. barbisetum* and the two unidentified Panamanian species, indicating that the beetles had not survived the first year on these plants.

In the spring of the following season (1925) only the five remaining cages were planted as before and three of these failed to develop any adult beetles. These were "wonderberry", *S. torvum* and *S. dulcamara*, showing that under the conditions of the experiment the beetles had been unable to maintain themselves on these three species beyond the second season.

At this time (1925) only the two remaining cages produced beetles of the spring brood and the experiment was carried no further as it appeared clear that the beetles were able to continue on these plants. They were *S. rostratum*, the plant believed to be the original food-plant and *S. melongena*, the egg-plant. We know of course from innumerable observations that the beetles maintain themselves indefinitely on potato.

It thus appears that not only do the beetles evince a differential choice among various Solanums and other solanaceous plants as was first clearly shown by Trouvelot, *et al.* ('33a), but the choice of the beetles is not always compatible with the larval requirements in the way of food. Thus even if the beetles are unable to maintain themselves for more than a year or two on plants that they will quite willingly attack we may readily understand how the potato-beetle and similar insects fail to widen their range of food-plants even though the instincts of the adults may vary considerably in directions incompatible with larval food requirements. What happens in such cases is that a certain proportion of the population is doomed to extinction due to faulty instinct of the parents in selecting unsuitable food-plants. If the environmental resistance rates high or the "viscissitudes of life" are excessive, as is usually the case, this factor plays an important part in the economy of the insect, but in the case of pests of agricultural crops where this environmental resistance is lessened by an excessively increased food-supply it becomes of very minor importance.

## LITERATURE CITED.

Feytaud, J.

1923. Etude sur le Doryphore. Ann. Epiphyties, vol. 9, pp. 209-306.

McIndoo, N. E.

1935. The Relative Attractiveness of Certain Solanaceous Plants to the Colorado Potato Beetle. Proc. Entom. Soc. Washington, vol. 37, pp. 36-42.

Trouvelot, B. & Grison.

1935. Variations de fécondité du *Leptinotarsa decemlineata* avec les Solanum tuberifères consommés par l'insecte. C. R. Acad. Sci., Paris, vol. 201, pp. 1053-55.

Trouvelot, B., D. Lacotte, Dussy & Thénard.

1933a. Observations sur les affinités trophiques existant entre les larves de *Leptinotarsa decemlineata* et les plantes de la famille des Solanées. C. R. Acad. Sci., Paris, vol. 197, pp. 273-275.

1933b. Les qualités élémentaires des plantes nourricières du *Leptinotarsa decemlineata* et leur influence sur le comportment de l'insecte. ibid., t.c., pp. 355-356.

Trouvelot, B. & J. Thénard.

1931. Remarques sur les éléments des végetaux contribuant a limiter on a empêcher la pullulation du *Leptinotarsa decemlineata* Say, sur de nombreuses espèces ou races végétales. Rev. Path. veg. Entom. agric., vol. 18, pp. 277-285.

## BOOK REVIEW

A Laboratory Guide to the Study of the Evolution of the Wings of Insects, by J. Chester Bradley. 2nd ed. Ithaca, N. Y. Daw, Illston & Co. 160 pages, 70 plates. 1939.

This is a revision of a similar guide published in 1931. The first 15 pages deal with venational nomenclature, origin of wings, nature of veins, and the archetype venation. It is noteworthy that the concept of the anterior and posterior media and cubitus is used in the discussion of the latter topic. The remainder of the guide consists of a synopsis of the venation in the principal orders of insects, both recent and extinct. This part of the text is arranged systematically, with the more generalized groups considered first. The discussion under each group stresses the evolutionary significance of the wings concerned. The 70 plates at the end of the guide include drawings of wings of 83 insects; the lettering of the veins has been left for the student.

This guide should prove very useful in general courses in entomology, as well as those dealing with morphology and evolution. It contains much information otherwise available only in numerous journals. In a few instances, however, statements about the wings of fossil insects are somewhat out-of-date. On page 40, for example, reference is made to the fact that Permotipula is known from only a single wing, so that we have no means of ascertaining whether this insect had two or four wings. However, a complete Permotipulid, having four wings present, was described by Tillyard in 1937 (Nature, Jan. 9, p. 66). One obvious error has crept into the text: on page 26 and plates 10 and 12, the ordinal name Protoblattaria has been used for all fossil cockroaches. Professor Bradley tells me that this use of the term Protoblattaria was unintentional, and is the result of an oversight which probably occurred when the manuscript was being arranged.

F. M. CARPENTER.

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